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ABSTRACT

A project was conducted for the following purposes: (1) to develop a workshop training package to prepare vocational education teachers to use vocational subject-specific modules; (2) to train those teachers to use the workshop package; (3) to conduct field tests of the metric modules with experimental and control groups; (4) to analyze, describe, and submit reports on the posttest results; and (5) to apply for Joint Dissemination Review Panel (JDRP) approval. Project staff worked in April and May 1983 with students and teachers in the Columbus, Ohio, Northwest Career Education Center to field test 5 of 55 existing metric educational modules in 77 vocational education areas. Students from preselected classes in auto mechanics, diesel mechanics, and merchandise distribution were randomly assigned to the experimental (36 students) and control (40 students) groups. The Statistical Analysis System program T test was used to examine the data collected. Comparing the raw scores of each category and then collapsing this data revealed that in the control group only 25 percent scored higher than 59, while in the experimental group 76 percent of the scores exceeded 59. A comparison of the means in the control and experimental groups demonstrated a significant difference and provided an overall picture of the effectiveness of the metric module. This study, while comparing groups drawn from a relatively small sample, indicates the instructional modules assessed were effective in imparting basic metric principles to the experimental classes. Replication of this study is recommended in enlarged control groups employing both pre- and posttest provisions to facilitate the assessment of gain rather than final conditions only. (KC)

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Field Testing Vocational Education

Metric Modules

Final Report

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Project Director

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June 1983

U.S. DEPARTMENT OF EDUCATION
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FOREWORD

The field testing of metric modules has been a step towards the integration of metric measurement into the educational and lifestyle fabrics of our lives. It has provided the opportunity to demonstrate the effectiveness of these modules and to assist teachers in the introduction of the metric system to students. This final report is intended to be a planning document to assist in the wider dissemination of metric education modules in our public school system. As such, it represents the beginning of a more indepth knowledge and use of the metric system in our Nation's schools, particularly vocational education programs where the field testing occurred. We wish to acknowledge the support and assistance of the U.S. Department of Education for this study.

The participation and assistance of the Columbus, Ohio Northwest Career Education Center, whose students were a part of both the Experimental and Control groups is particularly appreciated. The time of their instructors: Paul Baughman, Roger Howard, Sherry Puchstein, Deborah West, and Vaden West was fundamental to the success of the field testing and is gratefully acknowledged. The assistance of Dr. William S. Donaldson of Ohio State University's Comprehensive Cancer Center and Dr. Paul Campbell of the National Center was appreciated in the statistical analysis of collected data. Recognition is given to the Information Systems Division staff members for their efforts in the completion of this project: Carl F. Oldsen, Project Director; Clarine Cotton, Typist; and Janet Ray, Word Processor Operator.

Robert E. Taylor
Executive Director
The National Center for Research
in Vocational Education

EXECUTIVE SUMMARY

The Field Testing Vocational Education Metric Modules project was built upon the existence of 55 metric education modules in 77 vocational education areas. Of these, the five selected for field testing, contained revisions based upon the results of a prior study completed in 1977: "Development and Utilization of Metric Education Instructional Material in Vocational, Technical and Adult Education."

The purposes of the project were to: (1) develop a workshop training package to prepare vocational education teachers to use vocational subject - specific modules, (2) train these teachers how to use the workshop package, (3) conduct field-tests of the metric modules with Experimental and Control groups, (4) analyze, describe, and submit reports on the posttest results, and (5) apply for Joint Dissemination Review Panel (JDRP) approval.

Project staff worked with students and teachers in the Columbus, Ohio Northwest Career Education Center to field test the modules in April and May of 1983. Students from pre-selected classes in auto mechanics, diesel mechanics and merchandise distribution were randomly assigned to the Experimental (N=36) and Control (N=40) groups.

The Statistical Analysis System (SAS) program T TEST was used as the most appropriate statistical measure to examine the entire data set including the specific groups in Auto Mechanics (N=46), Diesel Mechanics (N=19), and Merchandise Distribution (N=11). Comparing the raw scores of each category, and then collapsing this data revealed that in the Control group only 25% scored higher than 59; whereas in the Experimental group 76% of the scores exceeded 59. A comparison of the means in the Control (41.6) and Experimental (69.0) groups demonstrates a significant difference and provides an over-all picture of the effectiveness of the metric module.

This study, while comparing groups drawn from a relatively small sample, indicates all three instructional modules assessed were effective in imparting basic metric principles to the Experimental classes. Replication of this study is recommended in enlarged Control groups employing both pre- and posttest provisions to facilitate the assessment of gain rather than final conditions only.

FIELD TESTING VOCATIONAL EDUCATION

METRIC MODULES

INTRODUCTION

This project built upon the existence of 55 metric education modules that were developed in 77 vocational education areas. The modules were designed to be an integral part of the student's vocational education curriculum and not as a one-shot effort to instill metric measurement principles. The purpose of the project was to field test five selected modules to determine their effectiveness in learning the metric system, and to provide the data needed for possible approval by the Joint Dissemination Review Panel (JDRP). Approval by JDRP would make the metric modules eligible for support by the National Diffusion Network (NDN), thereby increasing the dissemination and utilization of the products.

Background

The concern addressed by the project was that the 55 existing metric education modules representing 77 vocational education program areas were developed, pilot-tested, and revised but were not tested since revision. The extensive revisions that were made as a result of the pilot-test have made those test results inappropriate for validation the revised packages.

In July 1974, the Center for Vocational Education, now the National Center for Research in Vocational Education, was awarded a three-year contract by the Bureau of Occupational and Adult Education (USOE) for the "Development and

Utilization of Metric Education Instructional Material in Vocational, Technical and Adult Education." This contract had among its deliverables:

1. An Annotated Bibliography for Vocational, Technical and Adult Education.
2. A Position Paper describing the problems, issues, and alternatives involved in the development and implementation of metric instruction within vocational and adult education programs.
3. The development, pilot-testing, and revision of performance-based, job-specific, SI metric instructional materials for 77 vocational program areas.

The metric instructional packages were developed with the help of more than 45 vocational teachers skilled in over 100 program areas. A total of 77 packages were developed and pilot-tested in eight states. Over two-hundred teachers and approximately 5000 students participated in the pilot-testing of the materials. After pilot-testing the 77 vocational packages were revised and combined into 55 separate packages. A workshop was held in each of the ten USOE regions to help train trainers and develop a state plan for the dissemination and installation of these materials.

The materials then, developed with the help of vocational educators, are compatible with existing instructional practices. They are related to vocational content and reflect the latest specifications of metric standards. No provisions in the original Request for Proposal issued by the sponsor, however, made allowance for field-testing the revised packages.

Purpose and Objectives

The purpose of the project was to train vocational education teachers to use the existing metric education modules and to field-test the modules with their students. The major objectives to be accomplished were:

1. To develop a workshop training package to prepare vocational education teachers to use vocational subject-specific metric modules to teach the principles of the metric system.
2. To train, using the workshop training package, approximately 40 vocational education teachers at three sites located in the eastern, midwestern and western parts of the nation.
3. To conduct field-tests of the metric modules with test and control classes of vocational education students.
4. To analyze, describe, and submit reports of the posttest results.
5. To apply for JDRP approval of the metric modules.

Methods and procedures used to accomplish these objectives are described in the next section on methodology.

Methodology

As a follow-up to the original metric project previously discussed, project staff conducted a series of literature reviews to insure that we were aware of current trends and concerns regarding metric education in the United States. This provided several handouts for the workshop packages that set the stage and provided additional rationale for the project activities and to answer the question: "why metric and when?" and a summary survey of methodological trends in metric education.

The workshop materials and procedures were developed to train vocational education teachers to use subject specific metric modules. This involved the

identification of metric materials and literature that would assist in the training process. To this end a variety of instructional aids were obtained, some in multiple copies for use in the training packages for teachers and for subsequent use by students. A workshop agenda was developed that placed the emphasis on "hands-on" experience to assist in the familiarization process and keep to a minimum any qualms about dealing with the metric system. Explanations were provided of the project purpose, the experimental design, and procedures for evaluation. Included in the packet of materials were sections on metric literacy, spelling, spacing and symbols. Discussions were held on the metrification programs in the United States and elsewhere and our efforts to integrate metrification into our society. Also included was a directory of metric suppliers, publishers and national organizations concerned with metrics. Audio-visual aids were developed both to assist in workshop experience as well for later use with students. All materials were packaged in folders for ease of organization for reference use by teachers taking part in teaching the modules. Evaluation forms were developed to measure the effectiveness of the workshops and to use as a guide for improving the presentations. Copies of all training materials were reproduced in quantity to accommodate workshop requirements, and to facilitate teaching requirements when the modules were being field tested.

The development of the workshop training materials, posttest materials and related instructional aides proceeded on schedule and was completed by February 1981. Field testing of the modules was not accomplished until April 1983 due to a variety of circumstances (See Appendix I).

Development of a good working relationship with the four Columbus Area Career Education Centers proved to be very helpful, and particularly the

Northwest Career Education Center. Three appearances in January and February 1983, enabled us to enlist the interest and support of 7 teachers, 5 of whom participated in a March 1983 workshop, with field testing of 3 modules in April, and posttest data available in May.

The procedure for the field test was adhered to as in the original proposal was as follows:

* Existing groups of sophomore and junior class students enrolled in auto mechanics, diesel mechanics and merchandise distribution classes were listed alphabetically and randomly assigned to the experimental and control groups to make a division.
* The teacher used the metric module designed for the respective experimental groups and taught the module
* The control group received no instruction related to the specific metric module during the field test.
* Upon completion of the field test both groups took the posttest designed to measure metric knowledge and skills.
* Teachers were asked to comment on the usefulness of the module and field test.

The posttest was a 25 item test, 10 matching and 15 multiple choice questions. The first 20 questions were the same in each test, with the last 5 questions pertaining to the specific module being tested in that group. Approval was obtained from the Ohio State University Human Subjects Committee to administer the posttest.

The data collected from these posttests constituted 36 subjects in the experimental group and 40 subjects in the control group and was used for the statistical analysis of this report.

FINDINGS

Students in the existing classes for auto mechanics, diesel mechanics, and merchandise distribution were listed alphabetically and then randomly assigned to produce a division of these classes into Experimental (E) and Control (C) groups. Following data collection and coding the Statistical Analysis System (SAS) program T TEST was considered the most appropriate statistical procedure because it was particularly well suited to assessing the differences between the means, the number of categories under consideration, and the sizes of the test groups. It was run to evaluate group differences across the following sets of data:

- o Composite data set - Experimental group (N=36)
- o Composite data set - Control group (N=40)
- o Auto Mechanics only (N=46)
- o Merchandise Distribution only (N=11)
- o Diesel Mechanics only (N=19)

The T-tests were run with both equal and unequal variances. In each case, the more conservative t value is reported excepted as noted below. The null hypothesis of no difference between group means was tested using the appropriate t value at the 0.05 level of significance.

Experimental v. Control Group

The distribution of posttest scores without regard to specific modules produced the results shown in Table 1.

Table 1

Frequency Distribution of Scores

Scores	Experimental	Control
0-9		
10-19	2	2
20-29	0	13
30-39	3	6
40-49	4	6
50-59	1	3
60-69	5	7
70-79	4	3
80-89	12	
90-100	5	
Totals	36	40

Compared to the distribution of Experimental group raw scores, the range of scores in the Control group is somewhat collapsed, with only 25% of the scores in the Control higher than 59. Whereas over 76% of the scores in the Experimental group exceed 59. Although both groups had subjects that scored in the 10-19 range, the Experimental group clearly benefited from the instruction with the module.

Comparison of the mean for the Control group (41.6) versus the mean for the Experimental group (69.0) shows a wide and significant difference between those taught with the modules and those receiving no equivalent metric instruction. A similar comparison of the mode for the Control (28) versus the Experimental (88) reveals a wide range, as does a comparison of medians, 36 and 74 respectively.

A comparison of the means for the Experimental and Control groups produced the following:

Table 2

Comparison of Means for Experimental and Control Groups

Group	N	Mean	Std. Deviation	t	Degree of Freedom	Level of Significance
E	36	69.0	23.8	5.64	14.0	0.0001
C	40	41.6	18.3			

The usual variance test produced a non-significant result (P_F=0.12). Therefore, "t" was computed assuming equal group variances. The difference of means (41.6) in the Control and (69.0) in the Experimental is significant and provides an over-all picture of the effectiveness of the metric module. Similar analyses by module types are now examined.

Auto Mechanics

Table 3

Auto Mechanics

Group	N	Mean	Std. Deviation	t	Degrees of Freedom	Level of Significance
E	21	65.9	26.9	3.47	44.0	0.001
C	25	42.4	18.7			

Combining the three auto mechanics classes was done to submerge the effects of individual teachers and to increase the number of subjects for analysis purposes. T-test analysis reveals a probability of 0.001, signifying a very pronounced difference, again in favor of the Experimental subset. However, the three separate Auto Mechanics class means were markedly at variance,

ranging from a low of 36.8 to a high of 85.7. Why this was observed is not clear, and the data available did not support more intensive analysis, particularly with respect to ability level and/or previous metric instruction.

Merchandise Distribution

Table 4

Merchandise Distribution

Group	N	Mean	Std. Deviation	t	Degree of Freedom	Level of Significance
E	5	92.8	4.38	6.69	5.5	0.0008
C	6	34.0	20.9			

Comparing the square of the standard deviations in Table 4 indicates that the assumption of equal variance is not advised, but the level of significance of 0.0002 (using the equal-variance method) was computed and is still well below the threshold of 0.05. The values shown in Table 4 were computed using the unequal-variance method. Students exposed to the Merchandise Distribution module scored significantly higher than did the Control group, thus emphasizing the module's instructional effectiveness.

Diesel Mechanics

Table 5

Diesel Mechanics

Group	N	Mean	Std. Deviation	t	Degree of Freedom	Level of Significance
E	10	63.6	14.6	2.70	17.0	0.01
C	9	44.4	16.1			

The results shown in Table 5 indicate the Experimental group achieving more than the Control group at a high level of significance 0.01. The Diesel Mechanics module was very effective.

CONCLUSIONS AND RECOMMENDATIONS

This study, while comparing groups drawn from a small sample of vocational education students indicates all three instructional modules assessed in the study were effective in imparting basic metric principles to the Experimental classes. The integrity of the randomization was maintained throughout the experiment and provides justification for concluding that all modules can be used as designed. Additional replication involving a larger sample groups, additional classes, and in a variety of settings is encouraged to provide a more consistent and solid base for determination of module effectiveness.

Although not considered to be a major limitation of this study, certain students in the Control group did score higher on other criterion than did certain subjects in the Experimental group; all subjects probably had some metric exposure from outside the study bounds. Replication of this study should include pre- and post-test conditions facilitating assessment of gain rather than final conditions only. Exposure to metrics at other times while verified with the instructor, did not implicate a breach of the test procedure itself. However, had both Experimental and Control groups been screened prior to implementation of the experiment, thus quantifying the previous knowledge factor, the results of this study suggest that the net effect would have been to increase observed module effectiveness, not to detract from effectiveness. This is, module use seems to have imparted knowledge more than adequately, and lower levels of prior knowledge would have enhanced gain.

Summary

The field testing of these metric modules in a secondary level Career Education Center showed their effectiveness in imparting the basic principles of the metric system. Statistical analysis of the posttest results showed a significant difference in the squared means and demonstrated a level of significance well below our threshold of 0.05 in all cases. Replication of this study is recommended over enlarged groups to further prove the effectiveness of the modules.

APPENDIX I

PROJECT CHRONOLOGY

APPENDIX I

PROJECT CHRONOLOGY

Selection and utilization of field sites was not completed during the original time frame of the project, due to several extentuating circumstances. The original project director, John C. Peterson, had selectedand gained approval for three field test sites: Hartford, Connecticut; and Nashville, Tennessee; and Salt Lake City, Utah.

- o The Nashville workshop was held in April 1981 with the modules administered to the test groups. Unfortunately the posttest data was sent to Nashville too late in the school year to administer the test and measure the results. A follow-up posttest was considered, but it was far too late to achieve valid data.
- o The Hartford workshop was held the first week in June 1981 for 35 teachers, but suffered the same result in that the posttest were not sent in time to collect the data after administering the module.
- o The Salt Lake City workshop was not held because local officials declined at a late date.

In August 1981, the project director resigned to take a position at the University of Tennessee, and Carl F. Oldsen, Research Specialist in the Information System Division was asked to bring the project to completion.

A thorough assessment of the status of work revealed that a complete re-start on the field test phase of the project was necessary. Unfortunately only 60 days remained. Work to be completed included:

1. Selection of workshop sites.

2. Set-up, running, and completion of training workshops.

3. Administer posttests.

4. Prepare final report.

5. Submit JDRP application.

It was decided to seek a no-cost extension of the project to complete the work. time frame of the project, were approved in such a manner that hampered effective progress to be made as shown in the time-table.

During the extension no. 1, discussions were held with school districts in Pennsylvania, New Jersey and Georgia to schedule training workshops. The Pennsylvania workshop was to be a reality when it was cancelled by the school district in February 1982. The New Jersey and Georgia discussions were terminated due to lack of administrative support.

In extension period 2, our efforts to get cooperation from a school district were hampered by the fact that the extension left only 40 days to negotiate with schools. We were able to set-up a workshop with the Ford City, Pennsylvania Technical Vocational School in May of 1982, during extension period 3. This proved to not be successful in that the teachers involved did not have time to administer the module following the workshop.

Extension approval no. 3 received in May 1982 was minimally effective as summer vacation periods precluded discussing workshop training pending class assignments in the fall.

Extension number 4 was denied by the Government on August 19, 1982 citing failure to request the extension 45 days prior to the expiration project period.

Given the inability to utilize project funds past June 30, 1982 it was decided to continue the project in good faith and spirit to the original agreement at no cost to the Government.

This necessitated that all travel, workshops, and test sites be in the local Columbus, Ohio area following the original intent to field test five modules: Auto Mechanics, Automotive Merchandising, Dietetic Technicians, Food Distribution and Food Preparation. Contacts were developed to gain access to the Columbus and suburban school districts to obtain field test sites. This proved to be a time consuming process and telephoning proved not to be successful. It was found necessary to set-up visits to respective schools, with prior approval and notice, so that we could be on-site to demonstrate and display our metric wares. This provided the entry and led to the field tests within the local area.

APPENDIX II

POSTTEST

A) 0 2 1
B) ___
C) ___

STUDENT TEST BOOKLET

for

METRICS FOR VOCATIONAL EDUCATION

Introduction

The metric program you have just finished was designed just for you. Your answers to the test items will help us find out how good the materials are. Therefore, please answer all the questions as best you can.

However, you do NOT have to take this test if you don't want to. Also, you do not have to answer any questions you don't want to.

Directions

This test has 25 questions. Read each question carefully. There are two kinds of questions on this test.

One type of question is a multiple-choice question. Read each of the possible answers below the question. Pick the answer you think is best. Write the letter for this answer in the blank space at the end of the question.

Example:

0. There are _____ metres in one kilometre.

(a) 10
(b) 100
(c) 1 000
(d) 10 000

There are 1 000 metres in one kilometre. The correct answer is "c". So, the letter c is written in the blank.

A second type of question is also a multiple-choice question. Twelve possible answers listed at the top of the page. These same possible answers are used for ten questions. You are to put the letter of what you think is the correct answer in the blank.

THE NATIONAL CENTER FOR RESEARCH IN VOCATIONAL EDUCATION
The Ohio State University
1960 Kenny Road
Columbus, Ohio 43210

(Posttest for students in NCRVE metric project)

DIRECTIONS

Fill in each blank with the letter that shows the best answer.

Use this list to answer questions 1 - 10.

(You may use the same answer more than once.)

a. centimetres	g. litres
b. cubic centimetres	h. metres
c. cubic metres	i. millilitres
d. degrees Celsius	j. millimetres
e. grams	k. square centimetres
f. kilograms	l. square metres

1. The length of a basketball court might be about 30 _____.
2. A gallon of milk is not quite 4 _____.
3. The length of a new lead pencil might be about 18 _____.
4. A candy bar might weigh about 50 _____.
5. The height of a desk might be 74 _____.
6. The mass of a large cat might be about 5 _____.
7. The area of a person's thumbnail is usually between 1 and 4 _____.
8. A measuring spoon might have a capacity of 5 _____.
9. The thickness of a penny is about 1.5 _____.
10. The area of a desk top might be about 1.3 _____.

11. The correct way to write "seventeen degrees Celsius" is _____.
    a. $17^{o}c$
    b. $17^{o}C$
    c. 17^{o} c
    d. 17^{o} C

12. The correct way to write ten thousand kilometres is _____.
    a. 10,000 km
    b. 10 000 km
    c. 10,000km.
    d. 10 000 km.

13. The metric equivalent of one quart is _____.
    a. 0.95 litre
    b. 0.95 kilolitre
    c. 9.5 litres
    d. 9.5 millilitres

14. A cubic metre is a little more than _____.
    a. 1 cubic yard
    b. 8 cubic yards
    c. 27 cubic yards
    d. 64 cubic yards

15. Body temperature for a normal, healthy person is about _____.
    a. 7 degrees Celsius
    b. 37 degrees Celsius
    c. 67 degrees Celsius
    d. 97 degrees Celsius

16. A wood or plywood shelf for a storage closet might measure _____.
    a. 200 metres x 200 centimetres x 2 millimetres
    b. 200 metres x 20 centimetres x 2 centimetres
    c. 200 centimetres x 200 centimetres x 2 millimetres
    d. 200 centimetres x 20 centimetres x 2 centimetres

17. Very hot water for sanitizing might have a temperature of about _____.
    a. 5 degrees Celsius
    b. 45 degrees Celsius
    c. 85 degrees Celsius
    d. 125 degrees Celsius

18. The metric unit usually chosen to replace the pound is the _____.
    a. litre
    b. kilolitre
    c. gram
    d. kilogram

19. The metric unit usually chosen to replace the fluid (liquid) ounce is the _____.
    a. litre
    b. millilitre
    c. gram
    d. kilogram

20. A 325-gram quantity can also be given as _____.
    a. 0.325 kilogram
    b. 3.25 kilograms
    c. 32.5 milligrams
    d. 325 ounces

Questions 21 - 25 for both auto modules

21. A unit called the "newton metre" is applied when _____.
    a. checking tire pressure
    b. measuring liquid fuel
    c. tightening lug nuts and bolts
    d. estimating storage capacity

22. A unit called the "kilopascal" is applied when _____.
    a. checking tire pressure
    b. setting thermostats
    c. measuring liquid fuel
    d. tightening lug nuts and bolts

23. The parking space provided for an average car might be _____.
    a. 5 metres x 2.5 metres
    b. 50 centimetres x 25 centimetres
    c. 50 metres x 25 metres
    d. 5 kilometres x 2.5 kilometres

24. A compact car's gasoline tank capacity might be _____.
    a. 50 grams
    b. 50 cubic centimetres
    c. 50 kilopascals
    d. 50 litres

25. 0.65 kilogram of grease is the same as _____.
    a. 6500 grams
    b. 650 grams
    c. 65 grams
    d. 6.5 grams

APPENDIX III

WORKSHOP AGENDA

WORKSHOP

ON

METRIC EDUCATION

9:00 - 9:30	Introduction to metric and metric packages (contextual overview)
9:30 - 9:45	Measuring
9:45 - 10:15	Film: "Measuring with Metrics"
10:15 - 10:30	Module Overview
10:30 - 12:00	Unit I, Exercises 1-5

12:00 - 1:00	LUNCH

1:00 - 1:15	Discussion re: Unit I
1:15 - 1:30	Movie: "Meter, Liter, Gram"
1:30 - 1:50	From Known to Unknown Through Brainstorming
1:50 - 2:15	Unit 2 - Metrics in This Occupation - Table 2
2:15 - 2:30	Unit 2 - Exercises 6 and 7
2:30 - 2:45	Unit 3 - Metric-Metric Conversion
2:45 - 3:00	Unit 4 - Metric Instruments and Devices (Display)
3:00 - 3:15	Unit 5 - Metric-Customary Conversions
3:15 - 3:45	Review and Planning Implementation